

Musselshell River at Roundup: Detailed Floodplain Study



Presented to:

17th Annual AMFM Conference – Fairmont, Montana

Presented by:

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Senior Water Resources Engineer - Bozeman

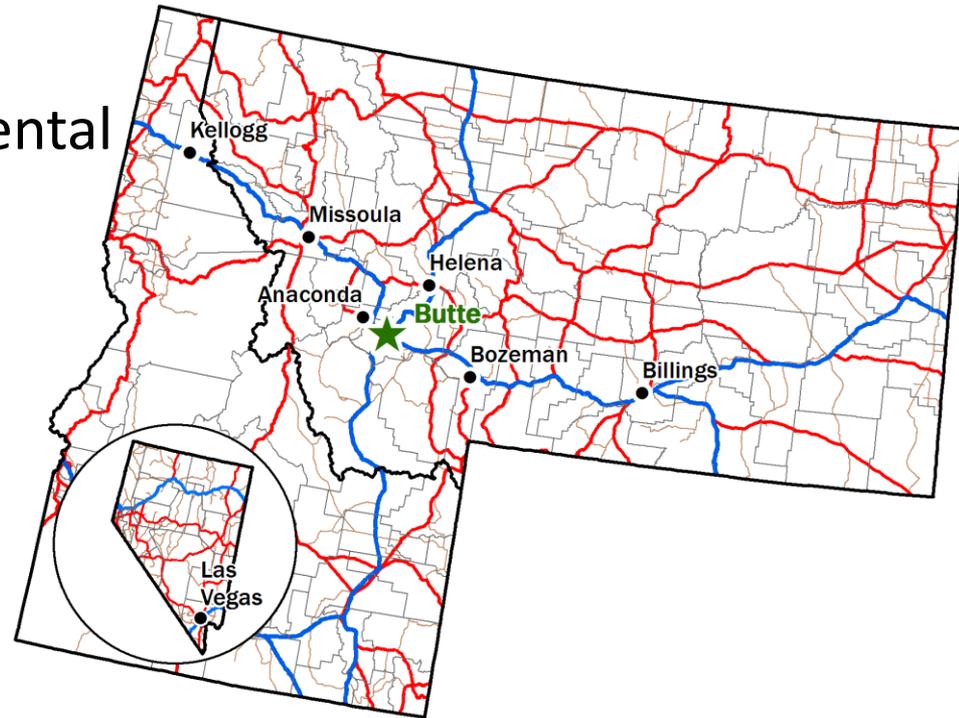
March 16, 2016

Presentation Outline

- Pioneer Overview – Who We Are, Who am I
- Project Overview – Musselshell River at Roundup
- GeoHECRAS Overview
- A Few Modeling Methods
- Preliminary Results/Lessons Learned

Overview of Pioneer Technical

- Engineering & Environmental Services Firm
- Offices (8) in:
 - Bozeman
 - Anaconda
 - Billings
 - Butte (Headquarters)
 - Helena
 - Missoula
 - Kellogg, ID
 - Las Vegas, NV
- Founded in 1991 in Butte, Montana
- Employee-Owned
- ~120 Employees



Brief Bio – Chad Bailey

- B.S. Civil Engineering – Bio-resource, MSU 2001
- M.S. Engineering, Univ. British Columbia 2003
- Research Fellow, Melbourne University 2004
- Professional Engineer – MT, OR, WA
- CFM, 2014

Musselshell River at Roundup

- May, 2011 Flood of Record ~15,000 cfs
 - Musselshell River over 4' above flood stage – 14.78' (USGS)
 - Closed Highway 87, 8' flood water at Busy Bee Café, 30 homes evacuated (Billings Gazette)
- March, 2014 Flood ~11,000 cfs
 - Musselshell River over 3' above flood stage – 13.24' (USGS)
 - Equivalent of 1" of rain in Roundup area (Weather Underground)
 - More than three dozen homes, businesses and ranches damaged
 - More than 400 people cut off from town (Weather Underground)



Kestrel Aerial Services, 2011 Flood Roundup

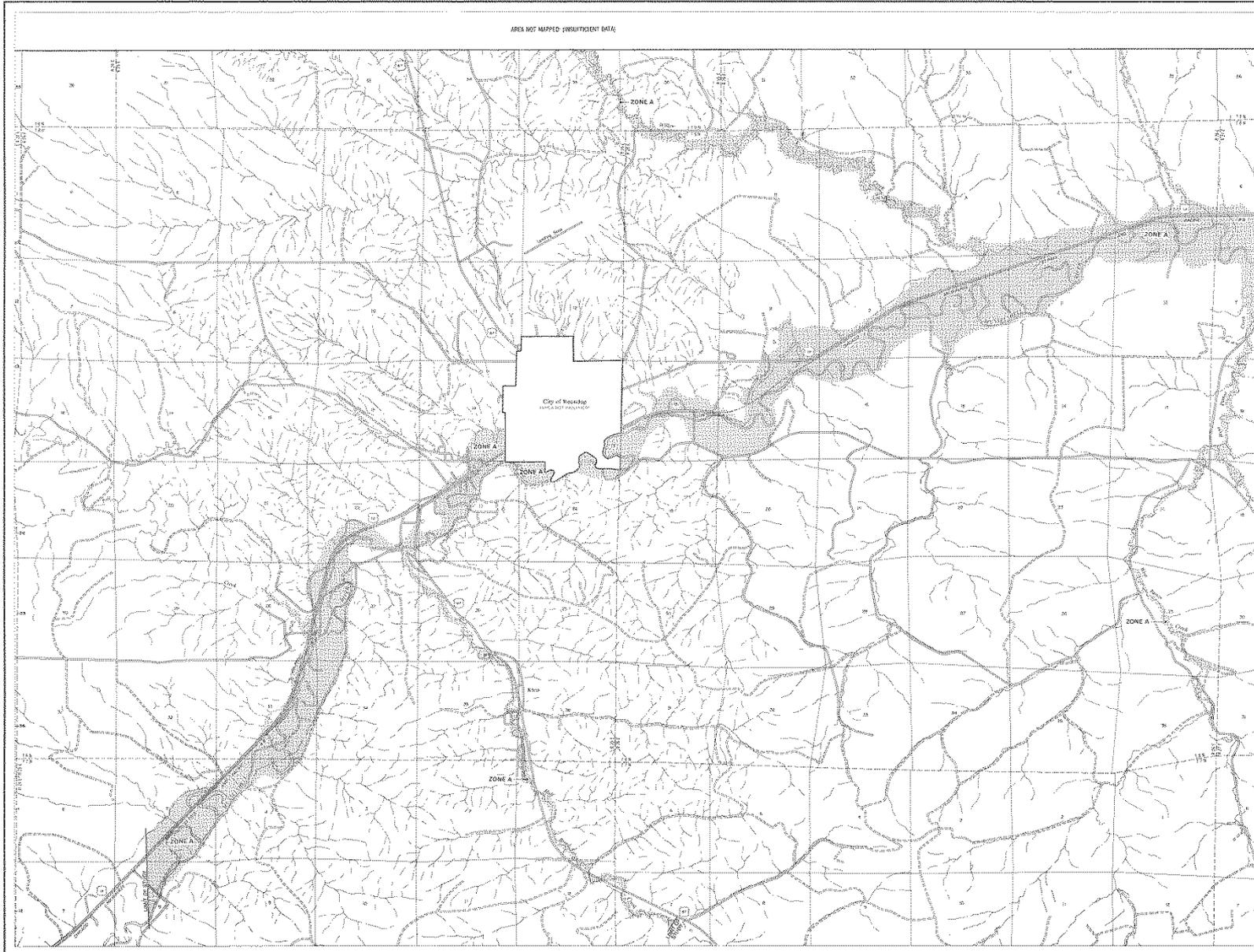


Musselshell River at Roundup

- 2011 Flood of Record ~15,000 cfs
- 2012 Lidar
- 2013 Roundup and Musselshell County request mapping
- 2014 Flood ~11,000 cfs (High Water Mark Survey)
- Old Existing Effective FIRMS

Community:	Community No:	Panels:	Effective Date:
Musselshell County, MT	300174	14A	5/29/1979 (Zone A)
Roundup, MT	300050	1B	3/18/1986 (Zone A)

1979 Flood Hazard Boundary Map



KEY TO MAP

SPECIAL FLOOD HAZARD AREA

ZONE A

Note: This map shows the boundaries of Special Flood Hazard Areas as determined by the Federal Emergency Management Agency and the National Flood Insurance Program. It is not intended to be used as a basis for insurance coverage or other financial decisions.

TO DETERMINE IF FLOOD INSURANCE IS AVAILABLE IN YOUR COMMUNITY, CONTACT YOUR INSURANCE AGENT, OR CALL THE NATIONAL FLOOD INSURANCE PROGRAM, AT (800) 475-6811 OR (800) 475-6810.

NATIONAL FLOOD INSURANCE PROGRAM

FHBM

FLOOD HAZARD BOUNDARY MAP

MUSSELHELL COUNTY, MONTANA

UNINCORPORATED AREA

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FOR MORE INFORMATION CONTACT:

COMMUNIFIED BY LETTER
EFFECTIVE DATE:
COMMUNITY PANEL NUMBER
300179 0014 A
EFFECTIVE DATE:
MAY 29, 1979

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL EMERGENCY MANAGEMENT AGENCY

NATIONAL FLOOD INSURANCE PROGRAM

FHBM

FLOOD HAZARD BOUNDARY MAP

MUSSELHELL COUNTY, MONTANA

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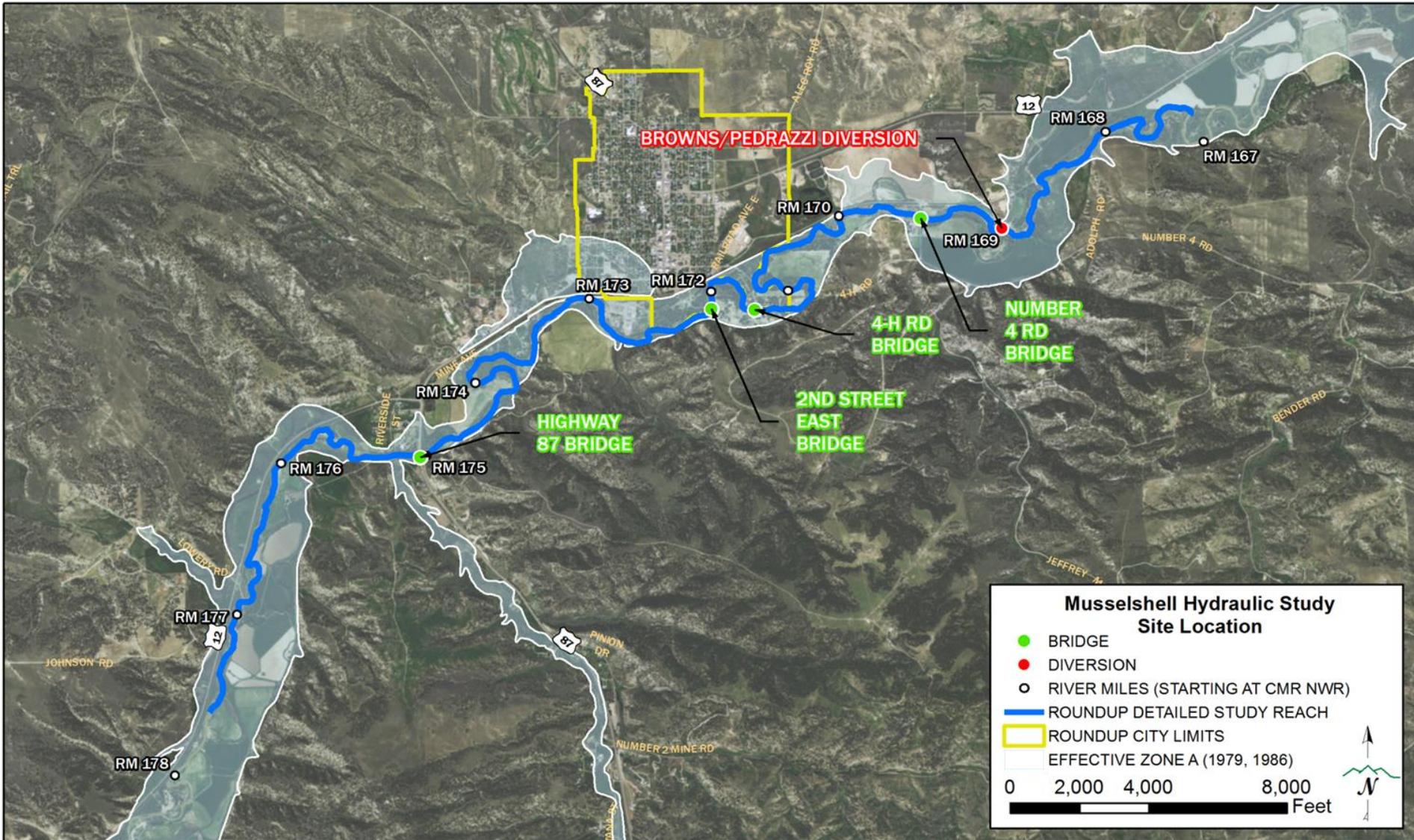
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FEDERAL EMERGENCY MANAGEMENT AGENCY

Musselshell River at Roundup

- Old Existing Effective FHBM & FIRM (Zone A)
- 2011 Flood of Record ~15,000 cfs
- 2012 Lidar (NRCS)
- 2013 Roundup and Musselshell County request mapping
- 2014 Flood ~11,000 cfs (High Water Mark Survey)
- 2014 Effective Zone A Digitization
- 2014 – Hydrologic Analysis, Structure Inventory & Roundup Reach Bathymetric Survey (Pioneer)
- Detailed Floodplain Study for approximately 10 miles around Roundup
 - 2 miles downstream of Newton/Pedrazzi diversion dam to 2 miles upstream of Highway 87 Bridge
 - RM 167.5 to 177.5 (Musselshell County Alignment)
 - 4 bridges and 1 diversion dam
- Detailed and Approximate studies for significant length of the Musselshell (Morrison-Maierle)

Site Location – Roundup Reach



Hydrology

- Developed by Pioneer under Phase I of Musselshell Project: Bathymetric Survey, Hydrology and Structure Inventory
- Data through Water Year 2014 – includes 2014 flood
- Log Interpolation between Lavina, Roundup & Musselshell gages

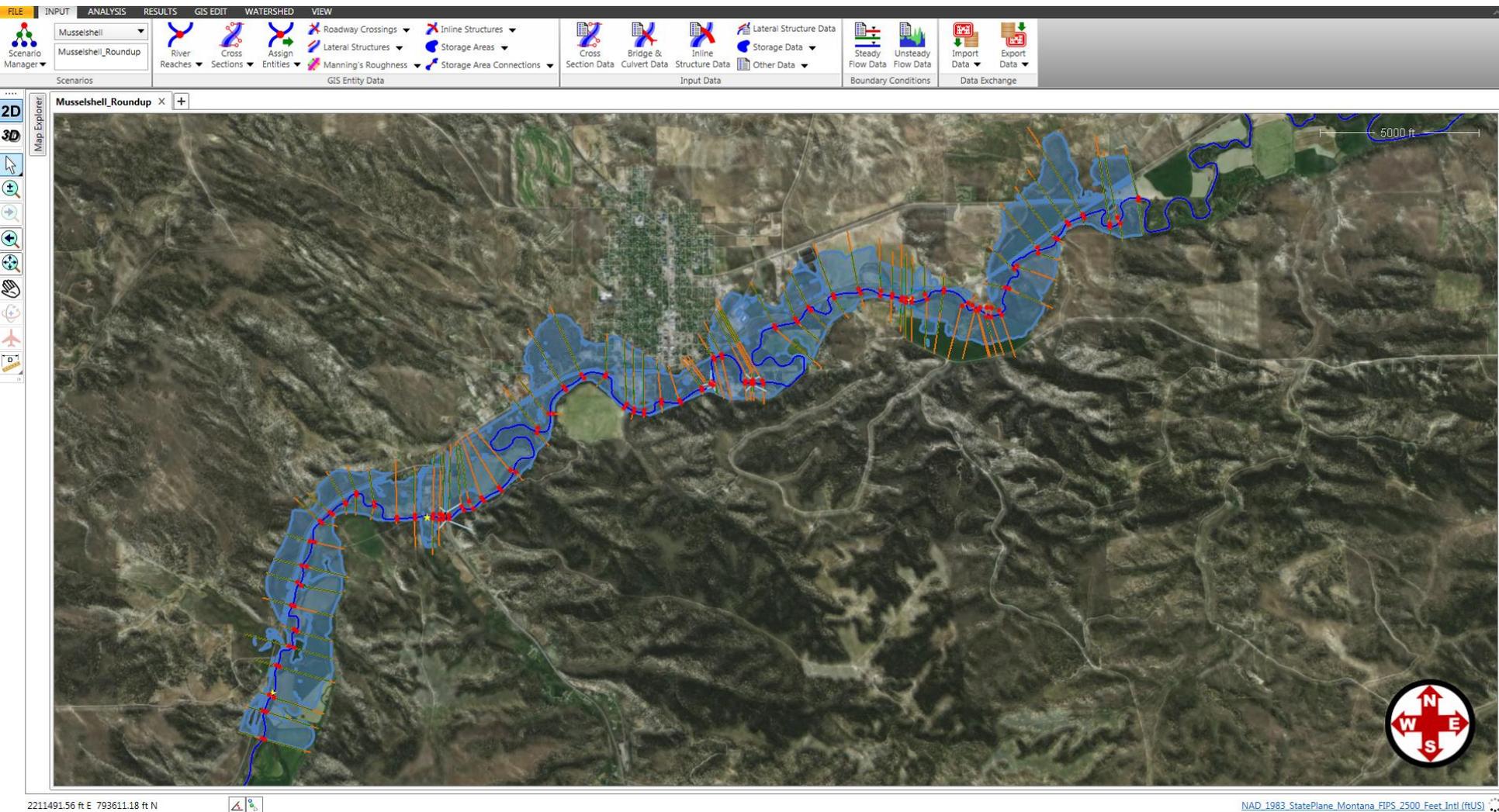
Node/USGS Station ID	Location Description	Peak Discharge					
		(cfs)					
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
		2-year	10-year	25-year	50-year	100-year	500-year
2100	Currant Creek	1,360	4,640	7,459	10,210	13,605	24,700
2200	Horsethief Creek	1,353	4,688	7,591	10,448	13,991	25,685
06126500	Musselshell River near Roundup	1,340	4,773	7,831	10,880	14,700	27,520
2400	N-F Ditch	1,338	4,776	7,839	10,893	14,720	27,558

Hydraulic Modeling - GeoHECRAS

- GeoHECRAS (CivilGeo)
 - AutoCAD & ArcGIS integration with HEC-RAS model engine
 - HEC-RAS 5.0 official release February/March 2016
 - HEC-RAS 5.0 support in development with release expected mid 2016 (per conversation on 3/10/16)
 - Import integrated DEM for floodplain and channel surface (integrated Lidar & bathymetric survey – Phase 1)
 - Automated cross-section development & resampling
 - 600-700 feet spacing on average
 - Assign manning's n, bank stations, flow lengths, ineffective areas & levees using CAD or GIS data
 - Access existing FEMA & FIRM data
 - Cloud based DEM data
 - Cloud based orthoimagery

Hydraulic Modeling - GeoHECRAS

- GeoHECRAS (CivilGeo) – Example Screenshot

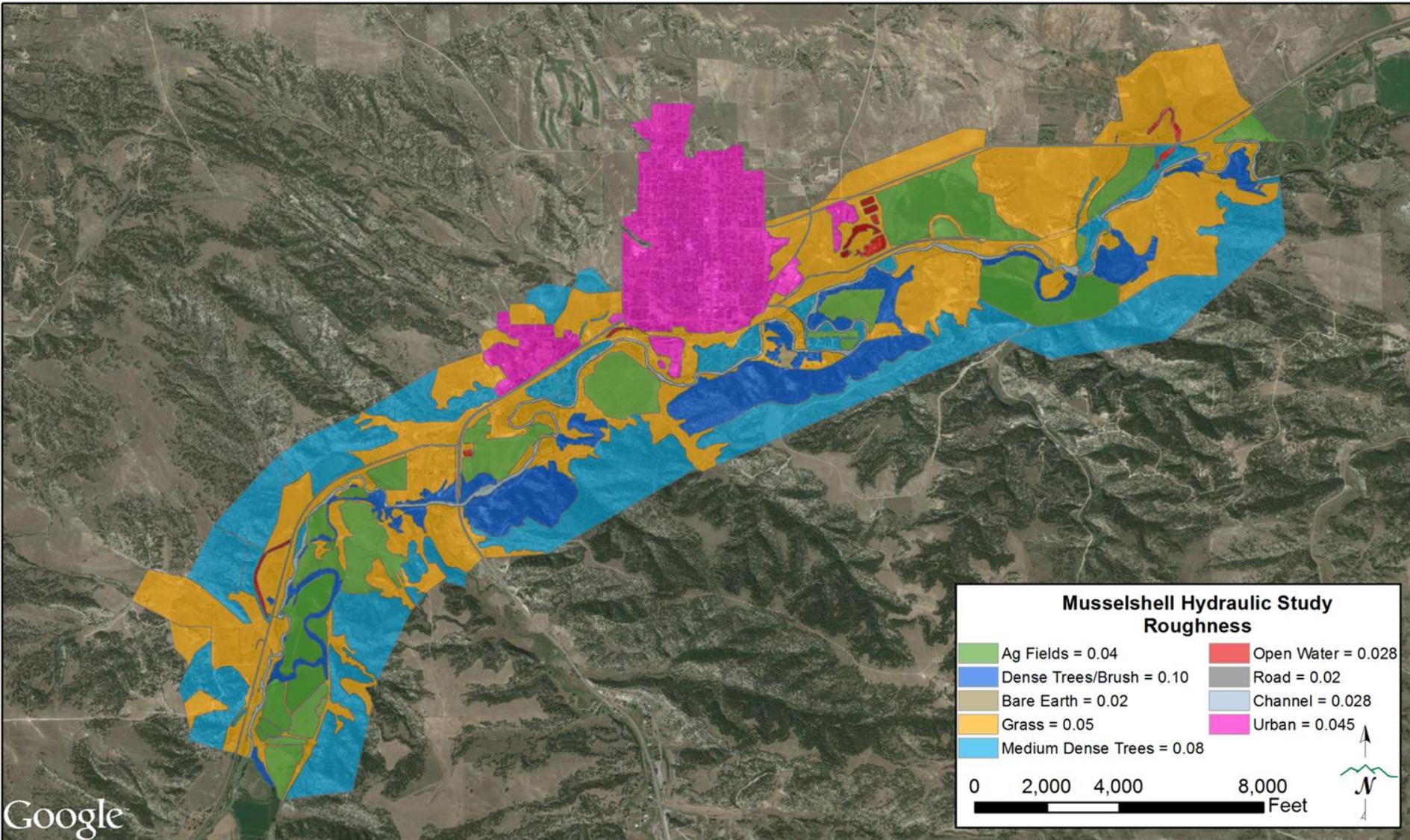


GIS Roughness Delineation

- ArcMap
 - Aerial imagery (2013 NAIP)
 - Visual polygon delineation – consistent land use
 - Assigned Manning's n attribute
 - Aerial imagery, field recon & photos, professional judgement
 - Chow (1959) & USGS (2006) methods to estimate initial roughness values
 - Adjusted during calibration procedure

Roughness Area/Land Use Type	Manning's n Value	Description
Main Channel	0.028	Coarse gravel ¹
Open Water	0.028	Same as main channel
Agricultural Field	0.04	Mature field crops, normal ²
Dense Tree/Brush	0.1	Heavy stand of timber, few down trees ²
Medium Dense Trees	0.08	Heavy stand of timber, few down trees (minimum) ²
Grass/Shrubs	0.05	Scattered shrubs, heavy weed ²
Urban	0.045	Finished concrete (0.015) + 15 to 50% obstructions (0.02) + small amount vegetation (0.01) = 0.045 ²
Compacted Dirt/Paved Road	0.02	Firm earth ¹
Bare Earth	0.02	Firm earth ¹

GIS Roughness Delineation



GIS Roughness Delineation

- Import shapefile into Geohecras
 - Assign Manning's n data

The screenshot shows the 'Assign Manning's Data' dialog box. It has a title bar with a close button (X). The dialog is divided into several sections:

- Cross Section Selection:** Contains two radio buttons. 'All cross sections' is selected. Below it, 'Selected cross sections:' shows '0 Selected' and a 'Pick' button.
- Polygon Coverage Data (optional):** Contains several fields:
 - 'Manning's area layer:' is a dropdown menu set to 'Mannings_n'.
 - 'Attribute field:' is a dropdown menu set to 'Mannings'.
 - 'Minimum value:' is a text input field with '0.02'.
 - 'Maximum value:' is a text input field with '0.1'.
 - 'Apply Manning's coverage data to overbank areas only' is an unchecked checkbox.
 - 'Insert ground stationing where polygon coverage intersects' is a checked checkbox.
- Default Values:** Contains three rows of text input fields with buttons to the right:
 - 'Left overbank Manning's:' with value '0.045' and a button '...'
 - 'Channel Manning's:' with value '0.032' and a button '...'
 - 'Right overbank Manning's:' with value '0.045' and a button '...'

At the bottom right, there are 'OK' and 'Cancel' buttons.

High Water Mark Calibration

- High flow event on 3-10-2014 ~ 11,000 cfs
- High water marks and personal observations surveyed by Great West Engineering on 3-14 and 3-19 of 2014
 - 13 measured points with varying accuracy

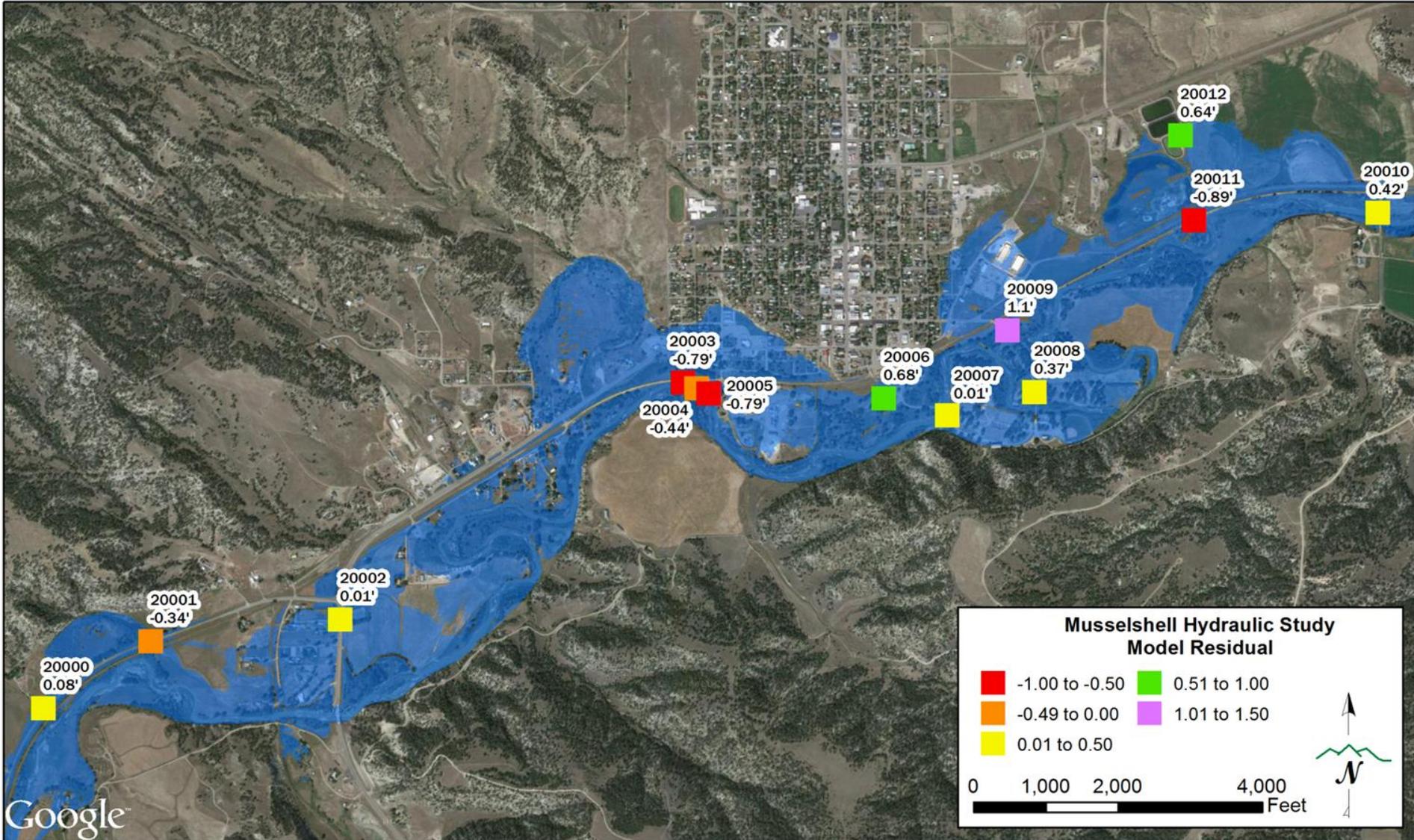


High Water Mark Calibration

- High flow event on 3-10-2014 ~ 11,000 cfs
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Node/ USGS Station ID	Location Description	County	River Station (miles)	Incremental Basin Area (mi ²)	Cumulative Basin Area (mi ²)	Log Interpolation of Gaged Analysis
						Estimated Discharge (cfs)
						Calibration
						3/10/2014
06126050	Musselshell River near Lavina	Golden Valley	205.7	19	2948	4890
1700	Painted Robe Creek	Golden Valley	199.5	25	2973	5001
1800	-	Musselshell	195	165	3138	5774
1900	Dean Creek	Musselshell	190.7	28	3167	5914
2000	Goulding Creek	Musselshell	185.7	67	3233	6250
2100	Currant Creek	Musselshell	182.8	75	3308	6643
2200	Horsethief Creek	Musselshell	177.2	235	3543	7972
06126500	Musselshell River near Roundup	Musselshell	175.1	455	3998	11000
2400	N-F Ditch	Musselshell	169.5	10	4008	10973
2500	Willow Creek	Musselshell	162.4	21	4028	10917
2600	Parrot Creek	Musselshell	158.7	276	4304	10221
2700	Krueger Spendiff Ditch	Musselshell	151.3	79	4384	10036
2800	Fattig Creek	Musselshell	146.3	31	4415	9966
06127500	Musselshell River at Musselshell	Musselshell	133.8	136	4550	9670

High Water Mark Calibration Results

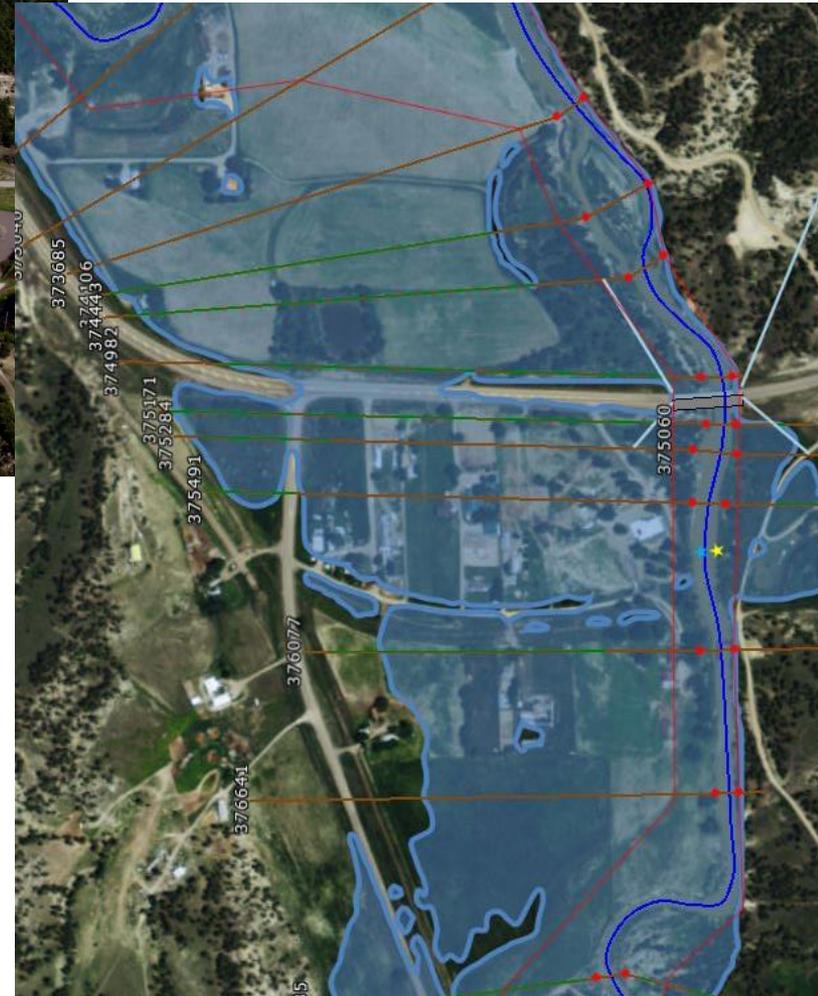


Highway 87 Comparison - Baseflood



Kestrel Aerial Services, 2011
Approx. 15,000 cfs

Hydraulic Model Result
Approx. 14,700 cfs



Mapping – DEM Changes

- Number 4 Road Repairs
 - 2012 Lidar shows the spur road as damaged from 2011 flood
 - Lidar collected in 2012
 - Road repaired after 2013
 - DEM modified to approximate the current road condition and resultant inundation (not part of preliminary results)

Mapping – DEM Changes



2011 Condition



2013 Condition



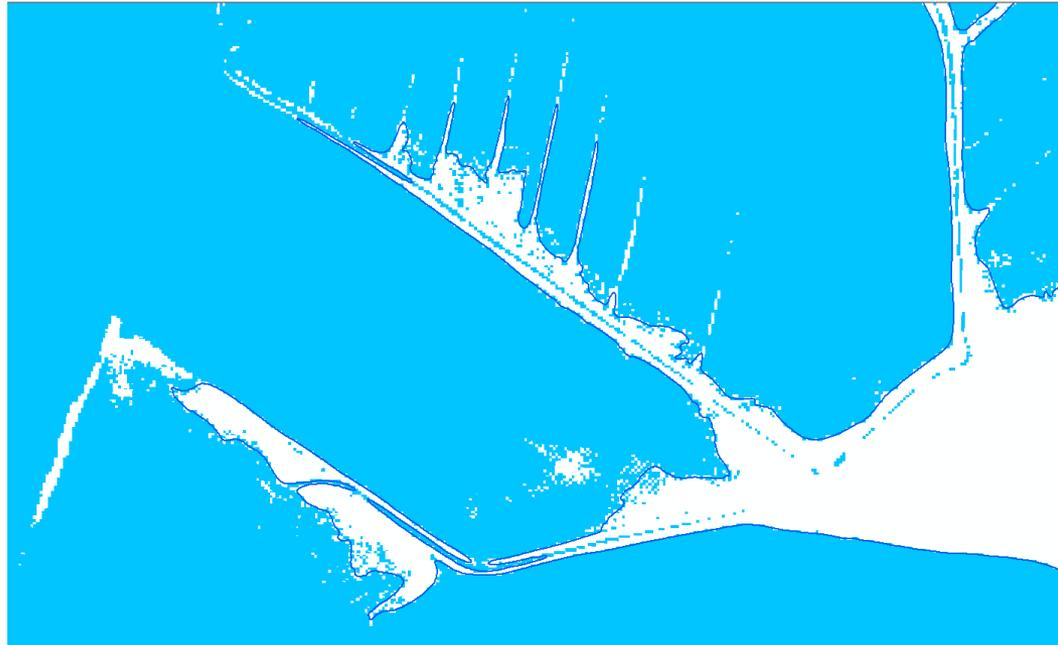
2015 Condition
(Looking East)

Lessons Learned - GeoHECRAS

- Iterations
 - Significant time saver
 - Cross-section layout
 - Roughness calibration
 - Bridge modeling (multiple openings?)
 - Check rough inundation without exporting
- Flood Extents
 - DEM was too big to process the flood extents in GeoHECRAS (8-2015 version)
 - Flood extents based on simplified digital terrain surface
 - First check on results
 - Flood delineation performed in Arc
 - HEC-GeoRAS depth grid and extents for Q100 & Q500
 - ArcMap subtracted flood depth grid from DEM

Lessons Learned - Mapping

- Preliminary Inundation Simplification
 - Inundation boundaries required simplification when compared to detailed Lidar based DEM (1-foot/pixel resolution, 0.7m Lidar)
 - Simplify and smooth polygon tools removed pixilation and jagged boundary – did not fix all the anomalies of high resolution Lidar



Next Steps

- Final Baseflood Boundary
- Floodway Analysis
- LOMR Submittal

Mapping – Preliminary Results

Public Presentations:

Web Scene – ArcGIS online

ArcGIS topography (not modeling DEM)

[Musselshell Web Scene on ArcGIS.com](#)

Animation video – ArcGIS Pro

[YouTube Link](#)

Questions?

- Acknowledgements
 - Steve Story, MT DNRC
 - Pete McCarthy, USGS
 - Chris Boyer, Kestrel Aerial Services

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